

## **MEA and Stack Durability for PEM Fuel Cells (New FY 2004 Project)**

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*Subcontractors:*

*Plug Power Inc., Latham, NY*

*Case Western Reserve University, Cleveland, OH*

### **Objectives**

- Develop an understanding of membrane electrode assembly (MEA) failure mechanisms encountered under real world operating conditions.
- Develop a high performance MEA and matched system operating conditions having enhanced durability (targeted for 40,000 hours operation with <10% performance degradation in stationary applications).
- Characterize life expectancy and performance degradation of the MEA in extended testing (>2000 hours) in a field-ready fuel cell system using reformat fuel.

### **Technical Barriers**

This project addresses the following technical barriers from the Fuel Cells section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year R,D&D Plan:

- O. Stack Material and Manufacturing Cost
- P. Durability

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### **Approach**

Proton exchange membrane (PEM) fuel cells are poised to change the landscape of power generation over the next ten years. Applications for portable power, back-up power, automotive power, and stationary power generation are being developed around the world. Estimates for the size of the fuel cell industry range as high as \$50 billion by 2010. For this to be realized, however, considerable technical challenges still remain. The most significant of these challenges are those of cost and system lifetime, where 40,000 hours of operation with less than 10% decay is desired. In order to

address these issues, we have assembled a team consisting of 3M, a materials and MEA manufacturer in the PEM fuel cell industry; Plug Power, a fuel cell stack and system manufacturer; and Case Western Reserve University, an electrochemical research institute with extensive knowledge of fuel cell technology.

In order to achieve the desired lifetime goals, the team will focus on (1) determining the root causes of MEA failure modes – membrane failure, catalyst activity losses, mass-transport losses, electrode losses (structural changes) and interfacial losses, and (2) using the information garnered from part one in

the development of new materials and system designs to improve durability. The project plan has several innovative approaches, namely: (a) use of new perfluorinated sulfonic acid ionomers; (b) development of ex-situ component aging tests designed to separate out effects of individual material degradation mechanisms and correlation with real-time and accelerated in-cell performance tests; (c) assembly and testing of MEAs using virgin and aged components to identify how those aged components affect cell performance; (d) use of novel experimental approaches for determining the loci of degradation within the cell; (e) use of computational modeling of non-uniformities within a cell to

characterize how non-uniformities affect failure modes and to design out the non-uniformities; and (f) system and materials perspective to understand the interactions of the stack design and operation on MEA performance and durability. Throughout this work, it is our intent to develop technologies that can accelerate the introduction of PEM fuel cell technology into a wider variety of applications that demand longer lifetimes. To accomplish this, Plug Power will evaluate the approaches and technologies identified to ensure that they are economically feasible in terms MEA cost and durability vs. a cost of energy model. The proposed work covers a three-year period.